

**UNITED STATES
DEPARTMENT OF THE INTERIOR
J. A. KRUG, SECRETARY**

**BUREAU OF MINES
R. R. SAYERS, DIRECTOR**

INFORMATION CIRCULAR

POTASH MINING IN GERMANY, 1945



BY

J. H. EAST, JR.

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Potash is one of the essential chemicals used in fertilizing soil deficient in natural minerals. Europe uses a large tonnage of potash in the form of easily soluble salts, and this is particularly true of those countries where the natural minerals in the soil have been exhausted owing to intensive cropping of the land. The application of potash to the soil in these countries is essential if normal crops are to be obtained; during the war, some European countries were unable to obtain sufficient potash, and productivity of the farming areas declined seriously.

The largest-known deposits of potash in the world, with the possible exception of Russia, occur in Germany, and the German output of processed salts constituted about 65 percent of world production prior to the war. The German potash-plant installations are large, modern, brick and steel construction and apparently built for a planned operation of many years. Two districts produced approximately 80 percent of the German potash; the Werra-Fulda district, near Vacha, had the largest production, and the Sudharz district, near Nordhausen and Sonderhausen, was second. (Fig. 1.) Hannover and Stassfurt were two smaller producers.

Potash fertilizers are rated in terms of potassium oxide (K_2O). The usual basis for calculation of production or application of the salt is to reduce the potash content to 40 percent K_2O .

GERMAN POTASH PRODUCTION

The potash production of Germany increased about 50 percent between 1936 and 1945; the increase during the war period was used largely in the greater than normal applications of the salt to the soil in the occupied countries in an effort to step-up productivity of the land.

The occupation of Germany by the Allies and the subsequent division of the country into zones of control has divided normal potash production about as follows:

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- 1/ The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Inf. Circ. 7405."
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	Percent
Russian zone	61
British zone	22
American zone	14
French zone	3

The production of potash in the various areas, now divided into zones of occupation, for the years 1936 to 1944 is shown in table 1. The same production, in terms of percentage of the total German potash production, is shown in table 2.

TABLE 1. - Production of potash in Germany, in 1,000's of metric tons K₂O

Year	Zones of occupation				Total
	Russian	British	American	French	
1936	648.4	311.3	162.9	37.2	1,159.8
1937	725.1	327.2	169.6	45.8	1,267.7
1938	830.2	379.7	175.6	64.1	1,449.6
1939	905.9	418.9	225.7	46.4	1,596.4
1940	1,157.7	406.5	258.0	37.6	1,859.8
1941	938.8	334.6	266.3	72.5	1,612.2
1942	1,151.4	360.8	276.6	69.8	1,858.6
1943	1,009.0	328.3	243.5	55.2	1,636.0
1944	997.0	338.5	224.0	45.0	1,604.5

TABLE 2. - Percentage of total German production

Year	Russian	British	American	French	Total
1936	54.0	29.5	13.4	3.1	100
1937	54.5	29.3	12.7	3.5	100
1938	55.5	28.3	11.8	4.4	100
1939	55.0	28.6	13.6	2.8	100
1940	61.4	22.2	14.0	2.4	100
1941	58.0	20.8	16.6	4.6	100
1942	61.4	19.7	15.0	3.9	100
1943	61.0	20.3	15.0	3.7	100
1944	61.0	22.1	14.0	2.9	100

SALES AND DISTRIBUTION OF POTASH

The sales, distribution, and prices of the various processed potash products formerly were controlled by the potash cartel, known as the Deutsches Kalisyndikat G.b.m.H., with main offices at Berlin. German, French, Palestine, Polish, and Russian production was handled through the cartel; Spanish and American potash producers operated independently of the cartel.

The Kalisyndikat is reported to have conducted sales of potash products, routing of shipments, and collection of all payments for a fixed percentage of the gross sales, and to have refunded to the mines the remainder of the payments for the shipments. The cartel was presumably an agency of the German government.

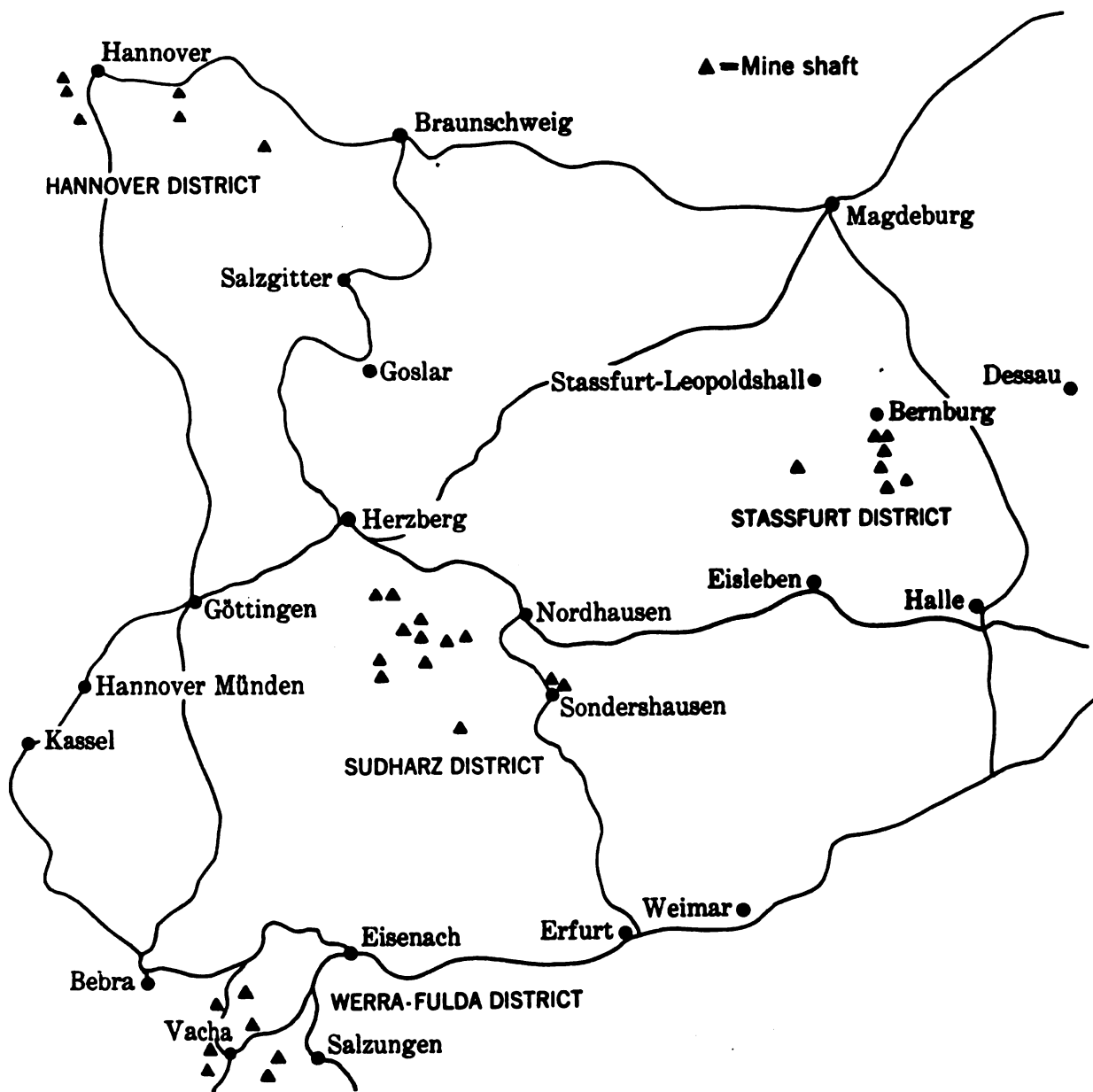


Figure 1. - Potash mining districts in Germany.

Data on sales of German potash in recent years are incomplete. The total sales of potash in Germany in 1936 and 1937 averaged 1,452,000 metric tons, of which 569,000 metric tons, or 39 percent, was exported. In 1938, a total of 1,676,000 metric tons was sold, but only 395,000 metric tons, or 23.5 percent, was exported. The sales of potash products in 1943 amounted to 4,404,780 metric tons containing 1,622,323 metric tons of K_2O ; in 1944 it was 4,244,913 metric tons containing 1,551,870 tons of K_2O .

Table 3 shows the tonnage of various potash products shipped from the mines in 1943 and 1944, including stock in the warehouses of the Kalisyndikat.

TABLE 3. - Potash shipments from mines in 1943-44, including stock in the warehouses of the kalisyndikat.

	1943			1944	
	Percent K_2O	Metric Tons		Metric Tons	
		Gross	K_2O content	Gross	K_2O content
Potash fertilizer ...	30	62,745	19,549	33,365	10,409
Potash fertilizer ...	38-42	2,260,400	925,016	2,142,272	876,676
Potassium chloride ..	50-60	786,230	403,378	797,458	409,037
Potassium chloride ..	Over 60	49,220	30,630	45,340	28,172
Crude potash salt ...	14-16	915,140	131,494	949,593	133,624
Carnallite	9-11	11,180	1,208	10,929	1,182
Potassium sulfate ...	50	91,515	45,849	81,595	40,940
Potassium-magnesium-sulfate	26-30	228,320	64,628	184,361	51,831
Total		4,404,782	1,622,322	4,244,913	1,551,871

1/ From Deutsches Kalisyndikat G.b.m.H. accounts division.

All of the products containing less than 50 percent potash (K_2O) are used as fertilizer, as well as a large portion of the 50 to 60 percent product and some of the potassium magnesium sulfate. About 90 percent of these products is used in agriculture; the chemical industry uses part of the 50 to 60 percent and all of the "over 60 percent" product. Potassium sulfate is used as a fertilizer and as a raw material in the chemical industry. Carnallite is used in the manufacture of metallic magnesium at the Wintershall mine and for the production of epsom salt at other mines.

Prior to the war, Germany consumed about 60 percent of the domestic potash production for fertilizer, 10 percent in the chemical industry, and exported about 30 percent.

The names of the potash mines and operating companies and the 1943 production are listed in table 4. These mines are segregated according to the zone of allied control in which they are situated. The official 1944 production statistics by individual mines is incomplete except for the total tonnage of potash produced, which was 1,604,500 tons K_2O , compared with 1,636,000 tons in 1943.

TABLE 4. - Potash mines in Germany

Russian Zone of Control

<u>Mine</u>	<u>Ownership</u>	<u>Production in 1943, in 1,000 metric tons of K₂O</u>
Kaiseroda	Wintershall, A. G.	164.4
Sachsen-Weimar	do.	85.2
Heiligenroda	do.	99.0
Gluckauf (Sonderhausen)	do.	125.3
Bismarkshall	do.	85.8
Bernburg	do.	10.0
Bleicheroda	Preussag, A. G.	129.2
Stassfurt	do.	21.5
Leopoldshall	do.	2.5
Rosleben	Salzdetfurth, A. G.	-
Sollstedt	do.	71.5
Aschersleben	do.	17.8
Westeregeln	do.	-
Georg. U. Unstrut	do.	57.9
Volkenroda	Burbach, A. G.	64.2
Krüggershall	do.	23.1
Solvay	Solvay, A. G.	33.1

British Zone of Control

<u>Mine</u>	<u>Ownership</u>	<u>Production in 1943, in 1,000 metric tons of K₂O</u>
Salzdetfurth	Salzdetfurth, A. G.	92.6
Hansa-Silberg	do.	62.6
Mariagluck	do.	0.4
Hann. Kaliwerke	do. (idle 7 years)	-
Siegfried-Gissen	Burbach, A. G.	48.5
Niedersachsen	do.	23.6
Wittskind	do. (idle 5 years)	-
Burbach	do. (idle 2 years)	-
Bergmannsseggen	Wintershall, A. G.	34.5
Rosenberg I	Kalichemie Concern	27.4
Friedrichshall	do.	38.7

American Zone of Control

<u>Mine</u>	<u>Ownership</u>	<u>Production in 1943, in 1,000 metric tons of K₂O</u>
Wintershall	Wintershall, A. G.	117.4
Hattorf	Salzdetfurth	126.1

French Zone of Control

Baden	Preussag, A. G.	55.2
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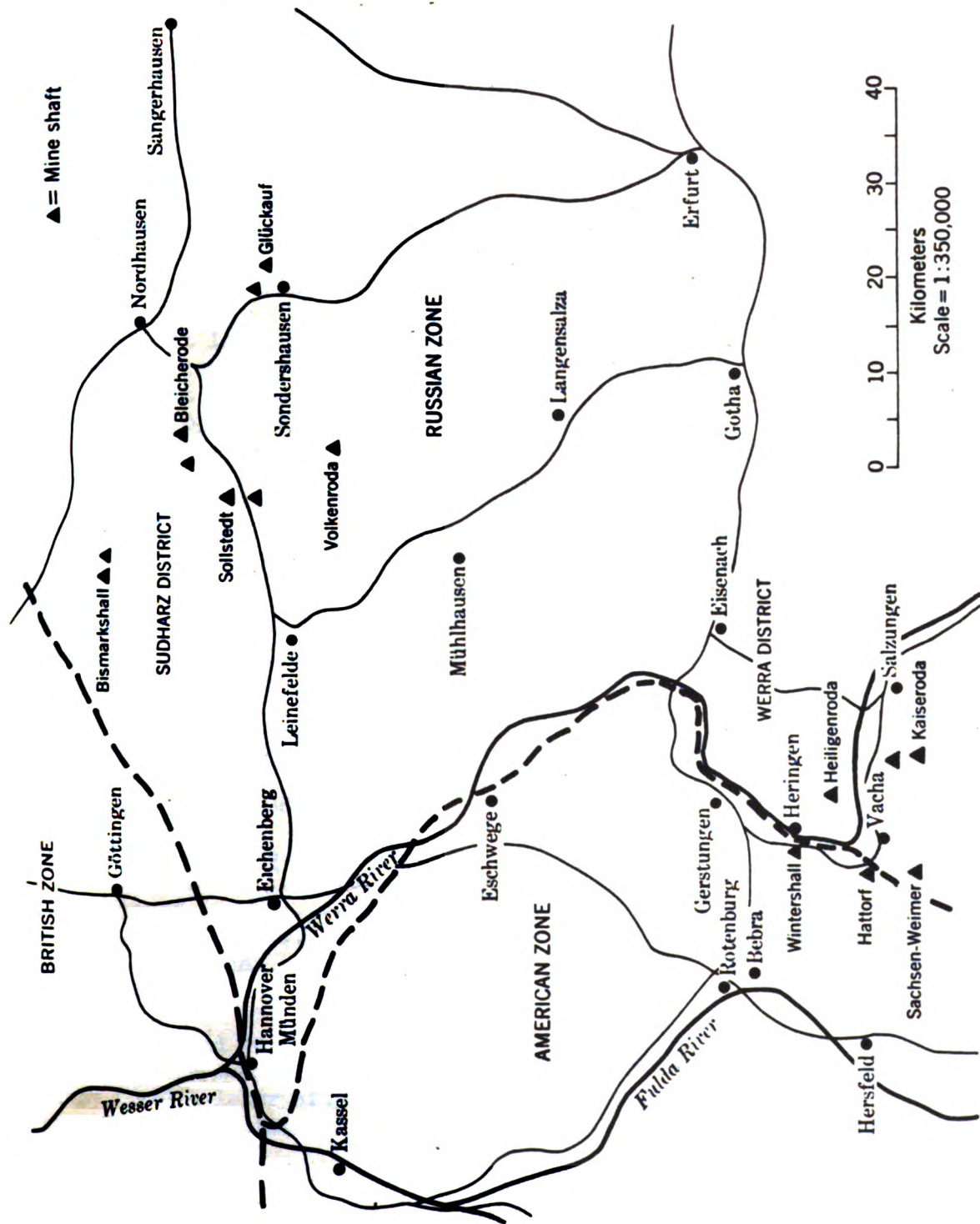


Figure 2. - Potash mines in the Werra-Fulda and Sudharz districts.

WERRA-FULDA DISTRICT

The Werra-Fulda potash mining district is in Hessen and Thuringen Provinces of central Germany. (Fig. 2.) It is, roughly, 40 air miles southeast of Kassel and is near Vacha and Salzungen in Thuringen; Hersfeld, in Hessen, is about 15 miles west of the Werra-Fulda district. The area is served by a branch line of the railroad between Kassel, Eisenach, and Erfurt. The Werra River flows through the middle of the district.

This district is the largest potash-mining area in Germany, having produced approximately 50 percent of the domestic potash mined in 1943 and 1944. Two of the five mines - Wintershall and Hattorf - are in the American zone, and the remaining three - Kaiseroda, Heiligenroda, and Sachsen-Weimar - are in the Russian zone. The Kaiseroda mine is the largest potash mine in Germany.

The deposit is fairly flat, dipping southeasterly about 2° from the horizontal; it ranges from 6 to 80 feet in thickness and is overlain with a bed of rock salt (NaCl), which is about 1,500 feet thick in some places. The deposit is opened by vertical shafts 1,685 to 2,500 feet deep.

The principal potash-bearing minerals found this deposit are:

Mineral	Chemical formula	Percent K ₂ O
Carnallite	KCl.MgCl ₂ .6H ₂ O	16.9
Hartsalz (mixture)	NaCl.KCl.MgSO ₄ .H ₂ O	13.9
Kainite	MgSO ₄ .KCl.3H ₂ O	18.9
Langbeinite	2MgSO ₄ .K ₂ SO ₄	22.7
Polyhalite	K ₂ SO ₄ .MgSO ₄ .2CaSO ₄ .2H ₂ O	15.6
Sylvinite (mixture)	KCl.NaCl	30.2
Sylvite	KCl	63.2

The five operating mines in the district are:

Name	Location	Control zone
Wintershall	Heringen	American
Hattorf	Near Vacha	American
Kaiseroda	Near Salzungen	Russian
Heiligenroda	Near Vacha	Russian
Sachsen-Weimar	Near Vacha	Russian

The mines and surface plants were not damaged seriously during the war, but considerable damage was inflicted upon the surface plants by the "forced" foreign labor after their liberation by American troops. Looting of supplies and sabotage of equipment constituted the principal damage.

WINTERSHALL MINE

The Wintershall mine is owned and operated by the Wintershall A. G.; it is located at Heringen, in the Province of Hessen. (Fig. 2.) The normal

daily production of raw potash salt is 5,500 tons (5,000 metric tons) containing 935 tons (850 metric tons) of K_2O . The deposit ranges from 6 to 50 feet in thickness in various sections of the mine, the average thickness being 11.5 feet.

Surface Plant

The raw potash salt, as hoisted from the mine, is manufactured into commercial products in a very extensive plant of brick construction. One section of the plant prepared fertilizer and higher grades of potash salts, and a newer section made metallic magnesium from carnallite.

Some of the crude potash as it comes from the mine contains sufficient K_2O to be used as a fertilizer without addition treatment, but most of the salt is placed in solution, and the various products are separated by fractional crystallization from saturated solutions.

The metallic magnesium is obtained by treating carnallite by an electrolytic process, which was kept secret until after the termination of the war. A brick stack 267 feet high, of unusual construction (fig. 3), carries away the chlorine fumes released in the process. Equipment is provided to manufacture finished and rough machine parts of pure magnesium as well as alloys of aluminum and magnesium; a grinding plant made magnesium powder for incendiary bombs. This plant produced approximately 6,000 tons of metallic magnesium in 1944.

Shaft and Hoisting

The deposit is opened by a vertical circular shaft about 18 feet (5.5 meters) in diameter and 1,620 feet deep. The shaft is lined with cast-iron tubing to a depth of 300 feet below the surface; this is below the ground-water level and is believed to be below any possibility of encountering water. The remainder of the shaft is lined with brick.

The iron tubing used to line the shaft is in segments 6.5 feet high and is curved to fit the circumference of the shaft. The lining is ribbed, and the segments are bolted together; the joints are calked with lead, and the space back of the lining, between the lining and the solid rock, is filled with concrete to prevent movement and to help carry the weight of the tubing. This type of lining is required by the Ministry of Mines as a safeguard against possible flooding of the underground mine workings.

The circular shaft is divided into four hoisting compartments, a ladderway, and a pipe compartment; two large compartments for cages extend across the diameter of the shaft, and a skip compartment is on each side of the cage compartments. A ladder escapeway is alongside one of the skip compartments, and the water pipes and power cables are in another compartment on the opposite side of the shaft. The ladders are wood, with steel rungs, and sollars are placed at 33-foot (10-meter) intervals.

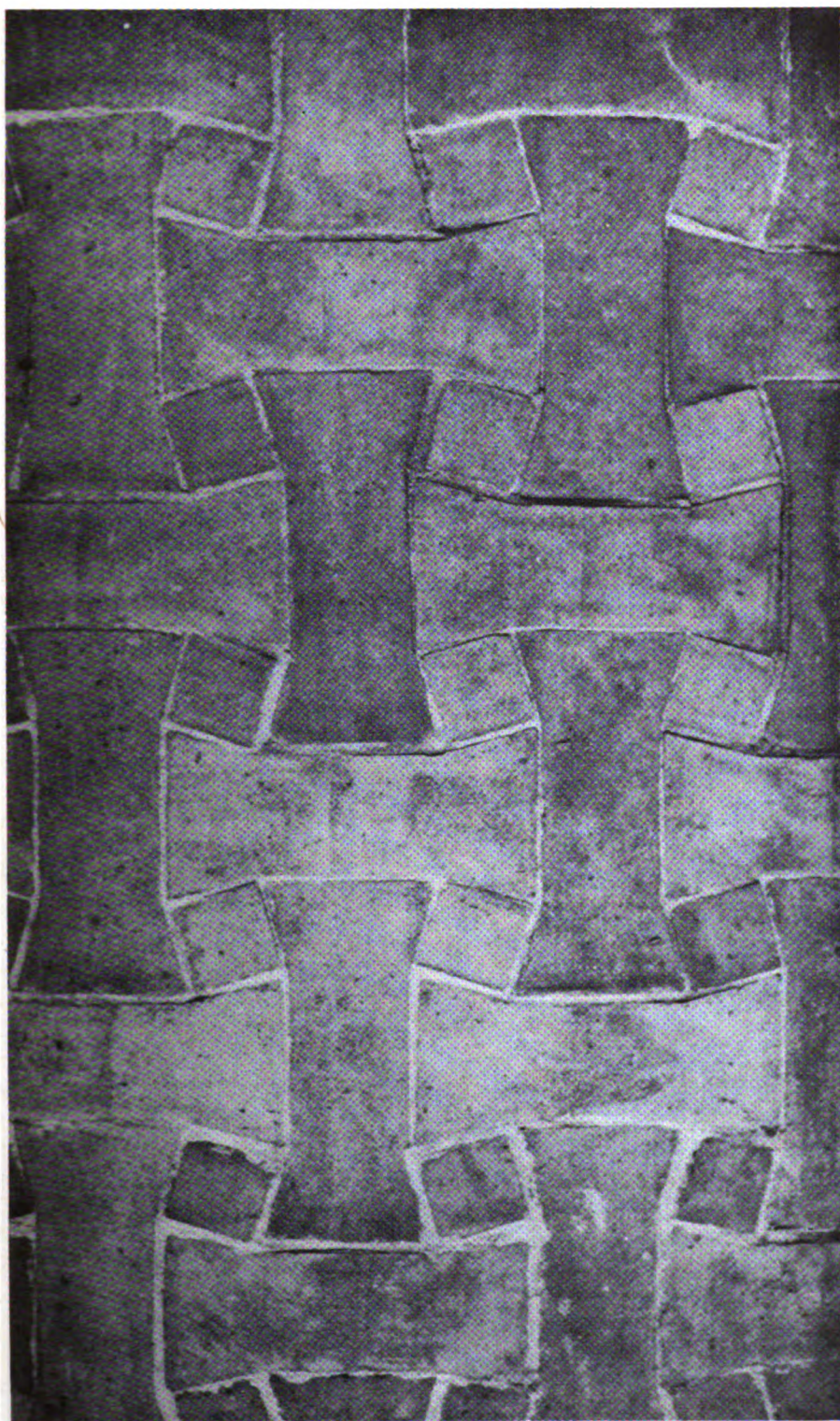


Figure 3. - Unusual type of masonry construction used in building a stack 267 feet high.



Figure 3A. - Headframe at Wintershall mine.

The headframe is of structural steel and unusual design (fig. 3-A), inasmuch as the cage hoist and skip hoist are placed at right angles to each other. The two head sheaves for the cage hoist are placed in tandem, one above the other, in the same plane, whereas the plane for the head sheaves of the skip hoist is at right angles to the cage sheave plane but otherwise an identical installation.

The Koepe system of hoisting is used, which in this installation consists of winding the hoist rope four times around a motor-driven, large-diameter, friction drum. The friction of the rope on the drum prevents slippage. A cage or skip is attached to each end of the rope, which is of such length that one cage or skip is in the lowest position in the shaft when the other cage or skip is in the highest position in the headframe. The friction-hoist drum is about 18 feet in diameter and is driven by a d.c. 550-volt motor. The hoist rope for the skip is 48 mm. (1.89 inches) in diameter, and the cage hoist rope is 40 mm. (1.57 inches) diameter; both ropes are 6 x 70 langlay construction with hemp center. A flat-wire rope 6 inches wide is used as a tail rope; it is attached to the bottom of each cage or skip and serves as a counterbalance and equalizes the dead weight of the cages or skips and the hoisting rope. This system of hoisting can be used only from one level, as the cages cannot be operated independently.

The cages are enclosed with perforated steel plate and equipped with end gates and overhead handholds. Conventional safety catches, or "dogs," are installed, but it is doubtful if they are effective in this type of hoisting, as in the event of rope failure both cages or skips will fall.

The electric hoists are equipped with overwind and overspeed safety devices. A recording apparatus shows graphically the number of trips, hour of the day, speed of hoisting trip, and the time required to hoist or lower the trip; the charts are examined periodically by the State mine inspector. Two independently operated brakes are provided; one is for ordinary service in hoisting operations and the other is for emergency use. The service brakes consist of manually operated bands with brake shoes of material resembling asbestos blocks acting on brake drums bolted to the rim of the large rope-friction drum; one or both of these brakes can be applied. The emergency brake consists of utilizing the braking action of the motor by making it act as a generator, similar to the regenerative braking used in many types of electrical equipment in America. It can be actuated manually and also is set to act automatically in case of overspeed.

The hoist ropes are covered with a shield lubricant that is said to be a plastic compound. The ropes are not cleaned before being inspected, and no attempt is made to lubricate them internally. The German mining law requires that hoisting ropes be removed after 2 years' service, but the law provides that permission may be obtained from the Inspection Commission at Berlin to use the rope an additional 6 months if it is found to be in good condition by the inspectors; a maximum of two extensions of 6 months each can be obtained. The time when a hoisting rope must be changed is not the responsibility of the mine management but is directed by the officials of the Inspection Commission, which is a division of the Ministry of Mines.

The hoisting speed for crude potash salt is 12 meters a second, or 2,400 feet a minute; the hoisting speed when handling men is 8 meters a second, or 1,600 feet a minute. The maximum speed of hoisting is fixed by the district mine inspector.

A brick building is constructed around the collar of the hoisting shaft to house the normal shifting of mine cars on and off the cages as well as the skip dump. The building extends to the head sheave platform and protects the hoisting ropes from the weather. The floors are steel plates attached to I beams, and the building is regarded as fireproof.

Mining Method

Potash is mined by the room-and-pillar method, with panel entries spaced 1,150 feet apart. The panel entries are driven in triplicate to the minable limit of the deposit, or to the limit of economic transportation, which in this mine is considered to be 1.8 miles (3 kilometers) from the hoisting shaft. The panel entries are driven 50 feet wide on 115-foot centers. The roof of the entry is arched, and no timbering is required. The rooms are driven 50 feet wide and average about 575 feet long to connect with the rooms driven from the next panel entry. A pillar 15 to 30 feet wide is left between rooms, and crosscuts for ventilation are driven at 100-foot intervals. Shaft pillars 500 feet in diameter are left to protect the hoisting shaft. Various spacing of panel entries has been tried, ranging from 825 feet to 1,700 feet, but the mine officials believe the present spacing of 1,150 feet to be the most efficient.

Scrapers and car-loading slides are used to load the potash in 1- and 3-ton capacity mine cars; the scrapers are of the box type, with a plain lip, and have a measured capacity of 3 tons. The scrapers are usually worked in tandem on one rope with one scraper at the face of the room when the other scraper is on the car-loading slide. The scraper hoists observed are belt-driven, electric, double-drum-type placed in a niche or offset on the opposite side of the entry from the loading slide. The hoist controls are placed at the loading slide, so that the operator has a clear view of the scraper as it approaches the slide and the car while it is being loaded. Scrapers travel at the rate of about 300 feet a minute (1.5 meters a second). The maximum distance for efficient scraping is regarded in this mine as 833 feet (250 meters). Three men work the scrapers as a unit crew; one man operates the hoist, and the other two men drill blast holes and attend to moving the head pulley as needed. The head pulley is attached to a removable wedge bolt inserted in a drill hole; the wedge bolt is taken out of the drill hole and reused. The scraper crews are paid on a tonnage basis, averaging 1.30 Reichmarks an hour (\$0.52 at an exchange rate of 1 mark equals 40 cents, U. S. cy.). The scraper crews load an average of 125 metric tons in 8 hours. The mine employs 430 men underground and attain an average production of 12.7 tons (11.6 metric tons) for each man underground including the supervisory personnel.

Note: Lower bed of potash salts is blasted with horizontal drill holes after top bed of carnallite has been removed

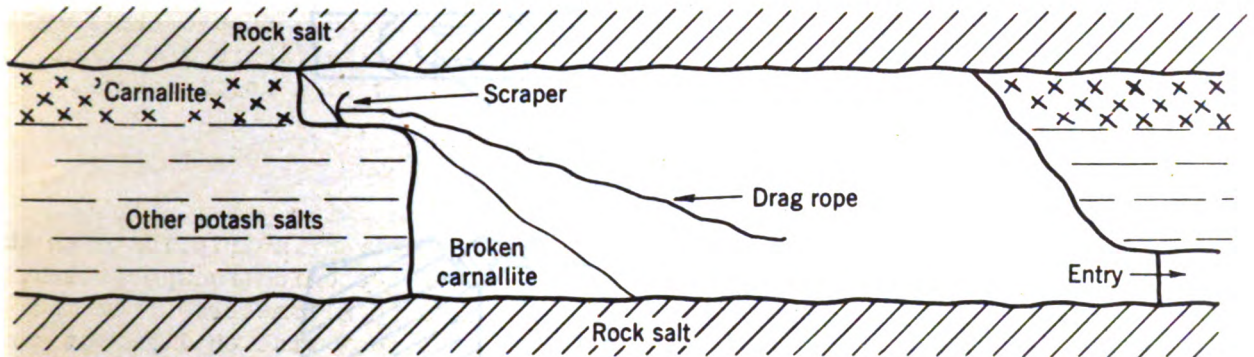


Figure 4. - Selective mining of carnallite, Wintershall mine.

Note: The miners drill from the room and are not exposed to a high roof

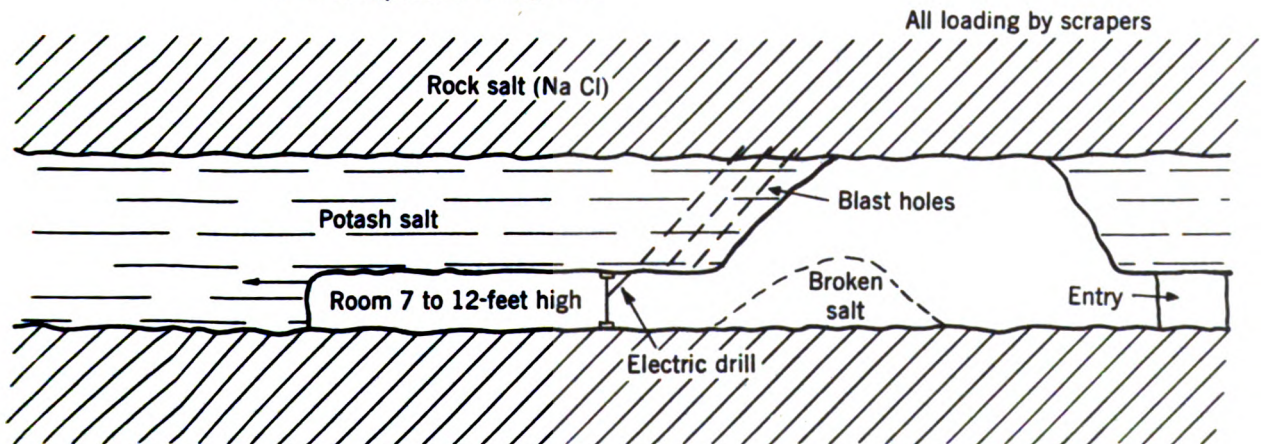


Figure 5. - A method of mining a thick bed of potash at the Wintershall mine.

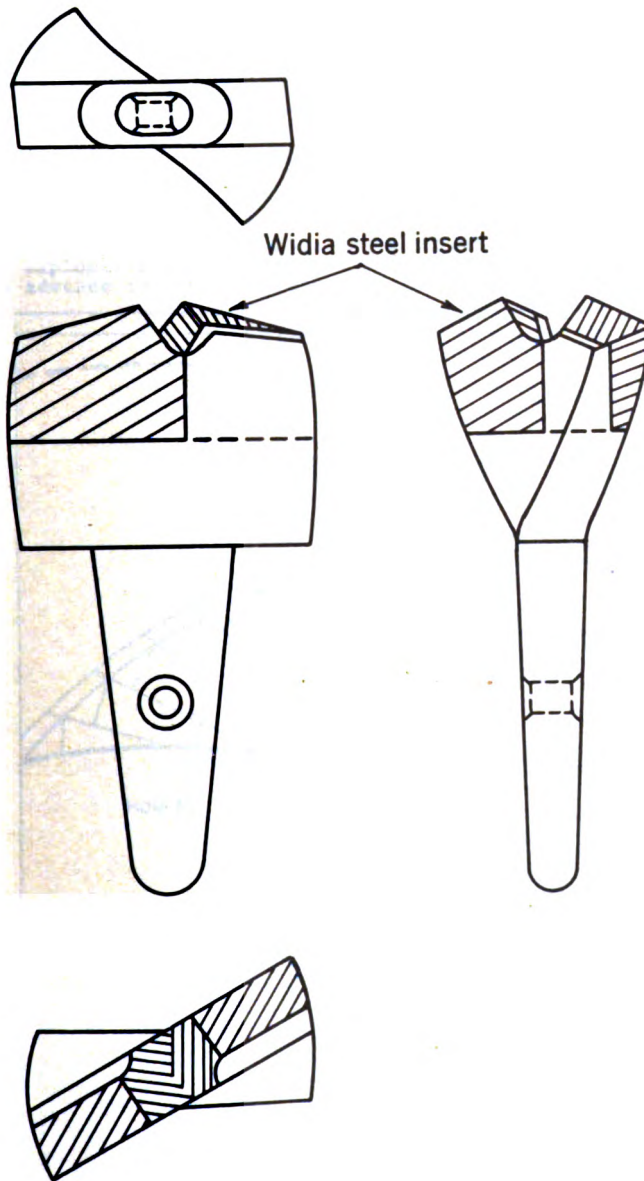


Figure 6. - Detachable drill bit with Widia steel cutting edge.

Hole Number	Length of of Meters	Tiers of holes	Length of drill hole in each tier Meters	Greatest advance cm.	Offset cm.
1	1.25	4	5.00	40	45
2	2.00	4	8.00	52	35
3	2.55	4	10.20	52	30
4	3.05	4	12.00	52	25
5	3.20	4	12.80	56	23
6	3.35	4	13.40	56	20
7	3.40	4	13.60	58	20
8	3.65	3	10.95	60	18
9	3.85	3	11.55	60	17
10	4.00	3	12.00	60	18
11	<u>4.00</u>	<u>3</u>	<u>12.00</u>	60	12
	50	40	121.45		

Of this 80 percent is loaded with dynamite or liquid air cartridges. Then $.80 \times 121.45 = 97$ meters. The explosives charge for this amount of hole is 63 kg. The advance is approximately 1.90 meters.

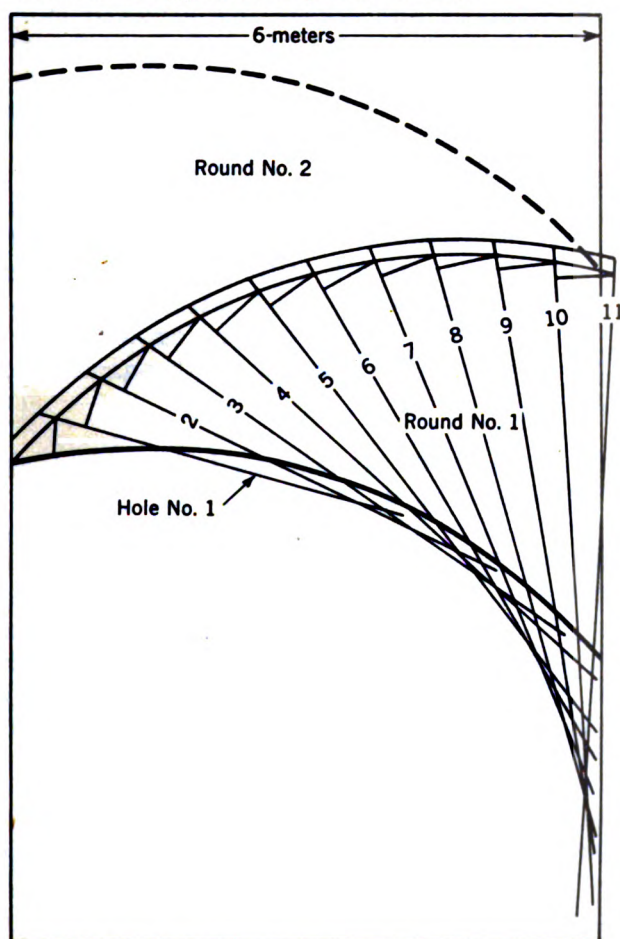


Figure 7. - Plan of drill hole round used in development headings 20-feet wide. The number of holes is varied according to the width of the face. The number of tiers of holes used in a round is varied according to the height of the face.

Figure 4 shows the method used to mine carnallite selectively for treatment in the plant manufacturing metallic magnesium. Carnallite frequently occurs at the top or bottom of the deposit, and in either instance it is mined selectively. If the carnallite is in the middle of the deposit, no attempt is made to mine it separately. Thick beds of potash salts are mined as shown in Figure 5.

Drilling and Blasting

Electric augur-type drills with aluminum bodies and weighing 132 pounds (60 kg.) are used to drill the raw potash. The drills are mounted on a column of pipe framework with a single screw at the foot for tightening. Steel racks are welded to the pipe framework to hold the drill in place while operating. Sectional augur drill steel in 1-meter lengths is used entirely; the augurs are a chrome-nickel alloy steel and designed so that the sections cannot be disconnected while inside the drill hole.

Detachable bits are used for drilling; the cutting edge is an insert of very hard alloy, probably tungsten carbide, named "Widia." The steel bit design is shown in figure 6; the alloy insert is attached to the steel bit, using copper between the alloy and the steel. The bits are said to be manufactured at the Krupp plant in Magdaburg; the mining company attempted to make the bits in the mine shops but was not successful. The alloy bit is reported as drilling 165 to 200 linear feet (50 to 60 meters) without resharpening; the same diameter drill bit is used for the entire length of hole. The average drilling speed in potash is said to be about 4 feet a minute.

The blast holes are drilled according to an unusual pattern that is said to be very efficient (fig. 7). Hole 1 is short and is comparable to a "cut" hole in American practice. The other holes are drilled as shown in the sketch and are fired with delay electric blasting caps. The advantages claimed for this pattern of drilling are uniform breakage and the relatively small burden on each drill hole. The holes are drilled up to 18 feet in depth; the number of tiers of holes depends on the thickness of the potash being mined; three tiers are used if the height of the face is less than 11.7 feet (3.5 meters). The number of tiers of holes used for different height of face is shown in the table in figure 7.

Sometimes, in wide rooms, one half of the room is drilled while scraper operations are in progress in the remainder of the room. These holes are blasted, and work is resumed while the second half of the room is drilled. This plan of drilling is not used unless the room is unusually wide or unless it is necessary for production to be continuous from that room.

Liquid oxygen is used at the Wintershall mine for all room and entry blasting, but so far as is known, all other potash mines use a low-density dynamite resembling the permissible explosives used in American coal mines. The liquid-oxygen plant is on the surface at a considerable distance from

the rest of the main surface plant. Carbon black is used as the absorbent for the liquid oxygen. The charge used is reported to be 1 liter of liquid oxygen for each meter of length of hole. The cartridges are 0.65 meter (25.59 inches) long and 38 mm. (1.496 inches) in diameter; the charges are detonated with No. 8-strength electric blasting caps connected in series parallel. The No. 8 strength blasting caps used in Germany are reported to be equivalent in strength to the No. 6 blasting caps used in the United States.

Mine officials state that the toxic fumes given off in liquid-oxygen blasting has not caused any ill effects on the mine employees, as the ventilation is sufficient to remove the gas. It is probable that the successful use of liquid oxygen underground is due to the practice of blasting at the end of the shift when all employees except the blasters are out of the mine, and the ventilating current removes the fumes before the men enter the mine on the following day.

A gas-proof room is provided underground about 2,000 feet from the hoisting shaft; this room is used by the blasters to fire all shots that are detonated electrically. The room is equipped with a telephone connected to the surface and is ventilated with compressed air. Blasts are not fired until the blasters have been notified that all the men are out of the mine. A basalt intrusion occurs at several places in the area opened by the mine workings, and sometimes when blasting near or alongside the basalt a large volume of carbon dioxide (CO_2) is liberated from pockets, completely filling the nearby mine workings.² If the carbon dioxide extends to the blasting chamber, the men remain in the room until the ventilating current removes the gas.

Haulage

Two methods of haulage are used in the Wintershall mine; the principal method is by endless rope and the other is electric. In the rope-haulage system, the rope is 26 mm. in diameter (1.0 inch) and is pulled by a 55-kw., 50-cycle, 500-volt motor belt-connected to a single-drum hoist. The rope is suspended about 5 feet above the track and travels at a speed of 125 feet a minute. The drum of the hoist is equipped with an endless liner a little larger in diameter than the haulage rope; the liner tends to prevent wear on the hoist drum and is said to increase the life of the haulage rope about 30 percent.

The 1- and 3-ton capacity mine cars are equipped with vertical rods extending above each end of the car; the rods are swiveled to permit movement, and the upper end of each rod ends in a yoke that will fit over the haulage rope. (Fig. 8.) The loaded car is pushed by hand to a mechanical device that moves the car yoke into the correct position and places the rope in the yoke. The haulage ropes from side entries are lifted mechanically to permit the loaded car to pass under the main-line rope to the loaded-car siding. The haulage ropes are taken around right angles by using large sheaves up to 8 or 10 feet in diameter. The cars are detached



Figure 8. - A 3-ton mine car with yokes at each end to attach car to the haulage rope.

from the rope at a siding near the mine shaft by increasing the height of the haulage rope above the track. The loaded cars are moved by gravity to the mine shaft and are stopped or retarded at will by a mechanical device that grips the sides of the mine cars as they pass along the track. The shaft tender operates the retarder by means of a hand lever placed near the shaft. A car stop prevents runaway cars from reaching the shaft; the stop is automatically held in the "stop" position at all times unless held down manually to permit the loaded car to pass.

Electric locomotives weighing 19.5 tons and having a drawbar pull of 90 tons on a 2 1/2-percent grade are used to transport cars in the sections of the mine having steep grades. Each locomotive is equipped with two pantograph-type trolleys.

The main haulage entries are driven 50 feet wide (15 meters); the loaded-car track is on one side of the entry and the empty-car track on the other; a well-surfaced automobile truck road is in the center between the tracks. Men are transported to their working places in gasoline engine-powered automobile trucks fitted to seat 15 persons; the truck is driven at a speed of approximately 30 miles per hour. No difficulty has been experienced with the exhaust fumes from the gasoline engine, probably because of the large cross-sectional area of the entries and the fairly adequate ventilation. Mine supervisors use bicycles to travel between working sections of the mine. The entries having rope haulage are graded to provide a fairly uniform track grade; the crude potash salt makes an excellent surface for the truck road.

Mine officials say that with a car spacing of 50 feet a single haulage rope will deliver 800 to 1,000 metric tons of potash salt to the mine shaft in an 8-hour shift; the average distance is approximately 1 1/4 miles. However, the tracks as well as the cars must be well-maintained, as one derailed car will cause the whole system to become inoperative.

An experimental installation of rubber-belt conveyors to transport the potash salt from the working face to the haulage entry has been used successfully, and it is planned to adopt this method in future development. The experimental conveyor belt was 120 centimeters wide (48 inches).

Ventilation

The mine is ventilated by electric fans operating exhausting. All except the last crosscut in rooms and entries are usually bulkheaded and sealed with cement plaster. The air is coursed through the haulage entries, but little attention is given to directing the air currents into the working places.

Gas

Pockets of methane are found at rare intervals, but generally the amount of methane is not sufficient to cause concentrations that are explosive. Pockets of carbon dioxide liberated along the contact with the basalt are regarded as much more hazardous than the small amount of methane.

HATTORF MINE

The Hattorf mine is owned and operated by the Salzdettfurth A. G.; it is at Phillipstadt, Hessen Province, in the Werra district. The mining method and underground equipment are similar to those of the Wintershall mine.

The deposit is opened by a vertical, brick-lined, circular shaft 17.5 feet in diameter (5.25 meters) and 2,383 feet deep (715 meters). The shaft is divided into four compartments placed in line across the diameter of the shaft; each compartment is 1.0 by 1.8 meters (3.3 by 6.0 feet) in cross section. A ladder escapeway is on one side of the hoisting compartments, and a pipe compartment is on the other side.

Two new combination skip and cage units of unusual construction are ready to be installed. The skip and cage are constructed as one unit, with a 2-deck cage forming the top part of the unit. The skip has a capacity of 13,200 kilograms (14.5 short tons), and each deck of the cage will carry 8 men. The sides of the cage are enclosed with perforated steel plate, and end gates are provided. (Fig. 9). The cage now in use is a combination skip and cage designed so that the floor can be folded back against the side of the skip when men are not being hoisted. The skip is below the cage section of the unit.

Hoisting equipment is similar to that at the Wintershall mine, except that the hoist has a capacity of about 500 tons an hour. The hoisting speed for potash salt is approximately 3,000 feet a minute (15 meters a second) and 2,000 feet a minute (10 meters a second) for hoisting men.

The Hattorf and Wintershall mines are the only potash mines in the American zone of occupation.

SUD HARZ DISTRICT

The Sudharz district is south of the Harz Mountains, near the city of Nordhausen, in the Province of Thuringen. (Fig. 2.) The potash deposits in this area dip more steeply than those in the Werra-Fulda district, and numerous rolls occur, which makes mining and transportation difficult. The Sudharz district is in the Russian zone of occupation.

GLÜCKAUF MINE

The Glückauf mine is owned and operated by the Wintershall A. G. and is the largest potash mine in the district. It is near Sonderhausen.

The potash deposit has been folded rather steeply (fig. 10), and this causes a modification of the usual room-and-pillar method of mining used in most potash mines. The entries are driven along the strike of the deposit, and series of inclined planes or slopes are used to transport the loaded cars to the haulage level. The cars are taken down the plane by an

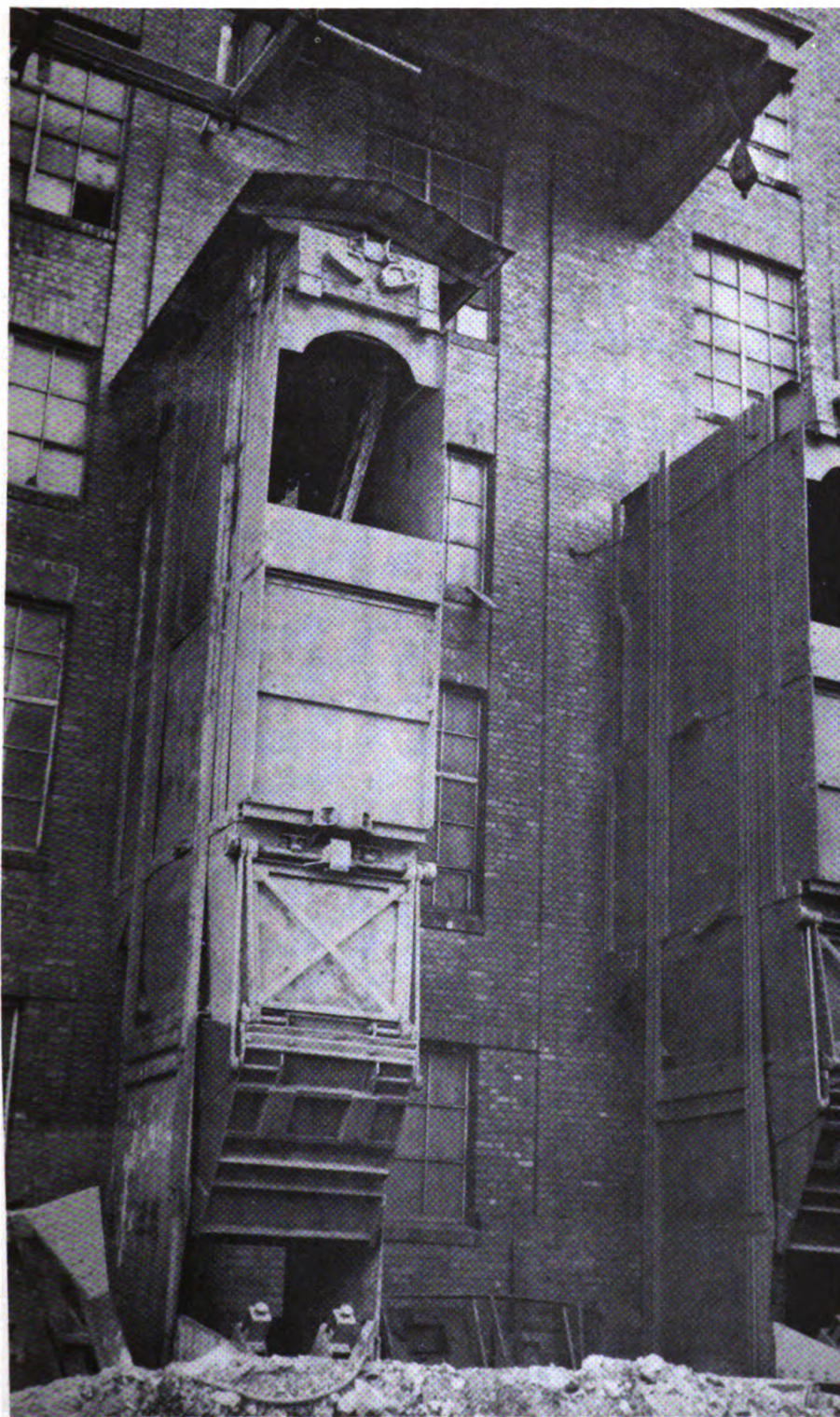


Figure 9. - Combination 2-deck cage and skip at Hattorf mine.

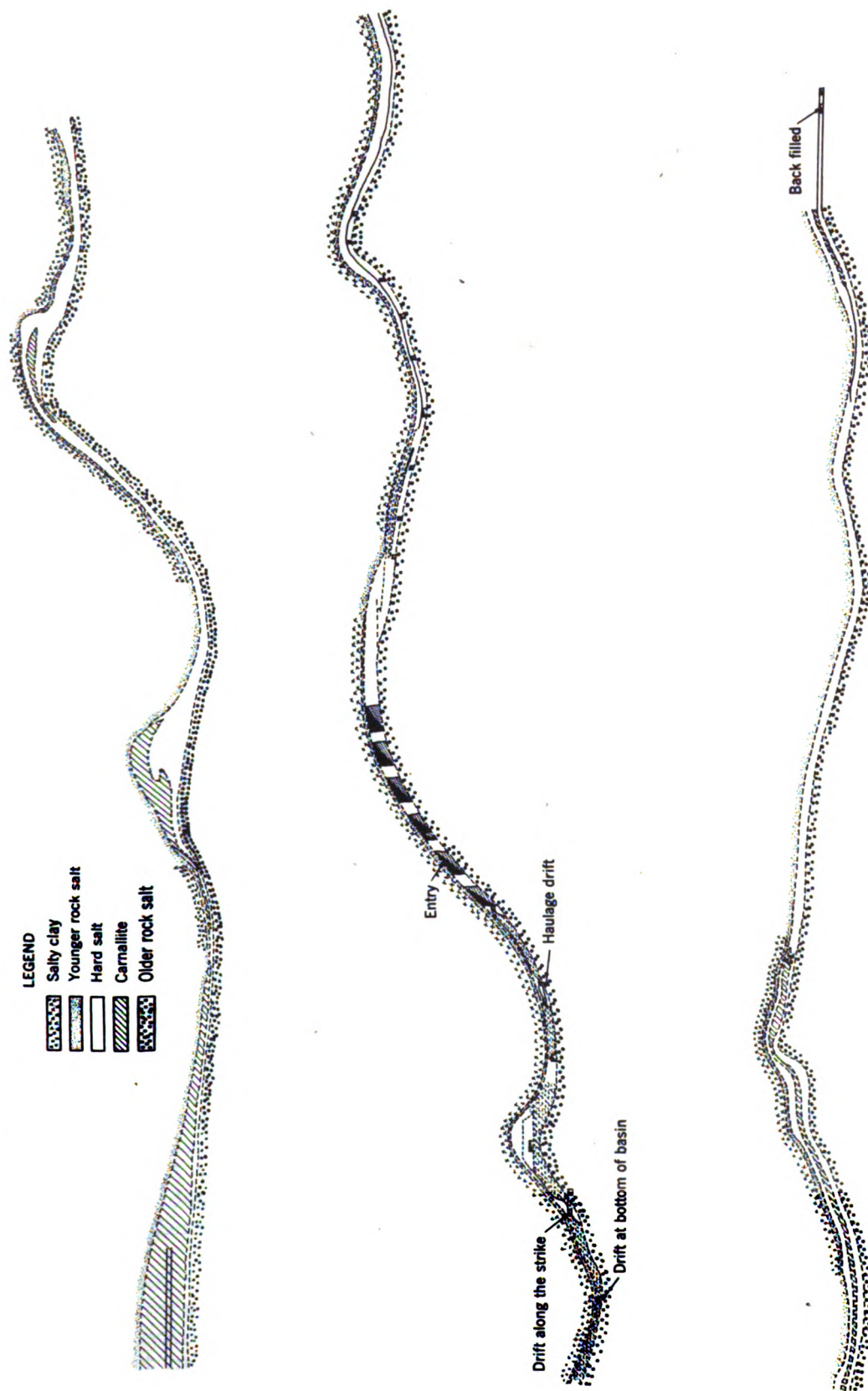


Figure 10. - Profile of potash bed, Sudharz district.

endless chain equipped with catches, or "dogs," that hold the cars securely in position. On reaching the haulage level, the loaded cars are attached to the haulage rope in the usual manner, as described for the Wintershall mine.

Backfilling

The mining laws of Germany require the mining companies to backfill the completed workings, but the law does not establish a definite time for doing this. The mining companies file a statement of their intention to backfill each room as soon as mining has been completed, but the officials select the places that are to be backfilled first. Some of the workings are not backfilled, and mining is said to have been completed for 15 years. Rooms and workings that have a tendency to cave are given preference over workings in solid formation.

Backfilling the mine workings is accomplished by washing the magnesium chloride, a waste product, through lined pipe to the area to be backfilled. One mine manager stated that 600 cubic meters of solids are washed to the backfill area in 1 1/2 to 2 hours, using 400 cubic meters of water. Dams are erected at all openings in the area to be backfilled, and the waste water drains away to a sump; the water is then pumped to the surface and is reused.

The waste magnesium chloride is in storage piles on the surface and is washed into the pipe line, using a firehose as a monitor. The opening to the pipe line is screened to prevent clogging with lumps and extraneous material. Backfilling operations usually require only a few hours each day, as it is necessary to allow the water to drain back to the sump. The magnesium chloride after the water drains away, sets in a hard, compact mass; this is a cheap and efficient method of backfilling and at the same time disposes of the waste products.

The backfill material is abrasive, and the pipe lines usually are lined with abrasion-resistant material. At one installation, the liners are made of basalt that has been melted and cast into sections 16 inches long; the space between the ends of the liners, after inserting in the pipe, are filled with neat cement and made water-tight. This liner is said to last indefinitely.

General

A considerable amount of coal is required in the processing plants to obtain a suitable shipping product. It is estimated that 0.70 ton of brown coal is required to produce 1 ton of K_2O . The coal commonly used is a brown-coal residue named "schwellkoks," which is obtained from the coal-distillation plants. Brown-coal briquettes also are used.

All potash mines in Germany were closed down in 1945, and many can not resume operations until after at least part of the supply of finished K_2O products are moved, so that additional storage space is available. It is estimated that about 700,000 metric tons of finished potash products are stored at the various mine plants in warehouses and stock piles.

Mine officials estimate that full mine production can be attained within 6 months following the resumption of operations, provided supplies and spare parts can be obtained. The estimated daily production of crude potash salt and its K₂O content of 10 principal mines in the Werra and Sudharz districts is shown in table 5.

TABLE 5. - Estimated normal daily production of potash salt at 10 principal potash mines

Mine	Metric tons	
	Crude potash salt	K ₂ O content
<u>Werra district:</u>		
<u>American zone:</u>		
Wintershall	5,000	850
Hattorf	5,950	625
<u>Russian zone:</u>		
Kaiseroda	7,000	770
Heiligenroda	4,000	425
Sachsen-Weimar	3,000	390
<u>Sudharz district:</u>		
<u>Russian zone:</u>		
Glückauf	4,200	504
Bismarkshall	2,800	364
Bleicherode	3,000	390
Sollstedt	2,080	271
Valkenroda	2,200	330

The number of men required for normal operation of these 10 principal mines is shown in table 6.

TABLE 6. - Number of employees required for normal operation

<u>Mine</u>	<u>Employees</u>
Wintershall	1,275
Hattorf	1,225
Kaiseroda	2,500
Heiligenroda	1,150
Sachsen-Weimar	700
Glückauf	1,350
Bismarkshall	800
Bleicherode	1,150
Sollstedt	855
Valkenroda	860

SUMMARY

The potash mines of Germany were not damaged seriously during the war; the principal damage at any of the plants that were visited was due to vandalism of "displaced persons" or former so-called "slave" labor.

The former sales agency, called the Kalisyndikat, controlled the output and sales of all potash salts marketed by Germany. Some method of controlling the distribution and sales of potash salts will be required before the mines can operate normally.

Essentially nothing is known of the present physical condition of the potash plants now in the Russian zone of occupation or what progress has been made in reestablishing the mine production. These mines constituted the major portion of the German potash production prior to the war.

The urgent need for potash fertilizer in most European countries makes it desirable that some plan be devised whereby all of the German potash mines and plants be placed in operation. Normal food crops can not be grown in Europe without this and other types of fertilizer.